

apparent double was a canal from Fons Juvente and a north branch of Tithonus. The latter observations have an interest, since the canal Ganges has been reported as having been seen double at the Lick Observatory.

A circular just distributed by the Centralstelle für Astronomische Telegramme, Kiel, states that a telegram, of which the following is a translation, was received from Teramo on August 31:—"Greenish-white spot on the northern cap of Mars. Length thirty to forty degrees. *Nix borea* apparently covers *Mare acidulum*. Cerulli."

THE MASS OF JUPITER.—It was more than twenty years ago, Prof. Simon Newcomb reminds us in the *Astronomische Nachrichten* No. 3249, that he called attention to the great value of observations on the minor planet Polyhymnia for determining the mass of Jupiter. Prof. G. C. Comstock's computations of the special perturbations of the elements of the former planet from the date of discovery in 1854, together with the observations made during the opposition of 1883, have enabled Prof. Newcomb to make this determination. The result obtained shows that the mass of Jupiter is $\frac{1}{1047.34}$ part the

mass of the sun. Other determinations of Jupiter's mass are shown in the following table, and also the weights assigned to them by Prof. Newcomb, who proposes to regard the weighted mean as definitive, and to use that mass in his work on the planetary theories.

	Jupiter's Mass.	Weight of Determination.
All observations on the satellites ...	1047.82	... 1
Action on Faye's Comet (Möller) ...	1047.79	... 1
Action on Themis (Krueger) ...	1047.54	... 5
Action on Saturn (Hill) ...	1047.38	... 7
Action on Polyhymnia ...	1047.34	... 20
Action on Winnecke's Comet (v. Haerdll) ...	1047.17	... 10
Weighted mean ...	1047.35	± 0.065

It is pointed out that in the interests of the astronomy of the future, it is very desirable to apply Gill's heliometer method to the continuous observation of a selected number of minor planets.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE forty-third annual meeting of the American Association for the Advancement of Science was held at Brooklyn, N.Y., from August, 16-22.

The marvel is that no meeting had previously been held in that great city. Overshadowed as it is by the greater metropolis of New York, its next neighbour, many strangers fail to realise that Brooklyn is one of the great cities of the world. By a recent act of the legislature its area has been doubled, and its population now exceeds one million, making it the fourth city in America; until the last census it was the third, but Chicago has now outstripped it.

Not merely as a portion of the metropolis of America, but also in those features which are distinctively peculiar to itself, Brooklyn offers unrivalled attractions to men of science. The massive bridge which spans the East River, connecting it with New York, is a world-renowned triumph of engineering. The United States Navy Yard attracts the attention of those who study applied science, and eleven thousand manufacturing establishments provide valuable object-lessons.

The city is also notable for educational institutions of the best character, including the Pratt Institution, the Packer, the Polytechnic, the Long Island Medical College, the Hoogland Biological Laboratory, a large and well-equipped High School for each sex, and several Roman Catholic Seminaries.

A marked feature of recent meetings of the Association has been the increasing number of affiliated societies which hold meetings in connection with the general Association. Two new accessions bring the number of these already up to nine, and next year the American Botanical Society will still further swell the list, which now includes the American Mathematical Society, the Society for Promoting Engineering Education, the Society for the Promotion of Agricultural Science, the American Microscopical Society, the Geological Society of America, the Association of Economic Entomologists, the American Chemical

Society, the Association of State Weather Services, and the American Forestry Association.

The citizens of Brooklyn entered into the arrangements with an evident determination to do everything to insure the success of the meeting. The reception at the Academy of Music and the Art Building, on the opening evening, was perfect in all its details. The excursions were of unusual number and variety, and included features of exceptional scientific interest, such as dredging expeditions by the steamer *Fish Hawk*, furnished by the United States Government. Special mention is also due to the elegant excursion to West End, and entertainment furnished by Mrs. Herrman, a patron of the Association, and of the sterling silver badges of her own design given as souvenirs.

The weather continued cool and comfortable throughout, so that all the external conditions were as favourable as possible. Teleologists even found evidence of providence and prevision in the unusual circumstance that nine century plants bloomed together to welcome the coming Association.

The attendance of members was well above the average of recent years, and if to the registry of the general Association be added the names of specialists attending the affiliated societies, it will raise the total to an aggregate comparing favourably with the largest meetings, notwithstanding that the depression of business and the fear of detention by railroad strikes exerted a deterrent influence.

Three evenings were occupied with popular scientific lectures. Paul du Chaillu spoke on the Vikings, their civilisation and expeditions; Edward D. Cope, on the relation of human structure and physiognomy to those of the other mammalia; and B. E. Fernow, on the battle of the forest.

The annual address of the retiring president, Prof. William Harkness, was on the magnitude of the solar system. An exhaustive account was given of the various methods of measuring the sun's distance. Many of Prof. Harkness' hearers were surprised to learn that but little accuracy has been attained for many years. He states as his conclusion after comparing all the corrected results of these various methods, that the sun's distance is 92,797,000 miles with a probable error of 59,700, and the diameter of the solar system, measured by that of its outermost member, the planet Neptune, 5,578,400,000 miles.

The address of Vice-President George C. Comstock, on binary stars, was of interest, as will be seen from the following extracts. After a general review of the subject, he said that the orbits of forty-two binary stars based on motion of over 80° have been computed. The shortest are δ Equulei and κ Pegasi, each less than twelve years.

ζ Cancri presents a curious study. Two stars less than a second apart revolve in an ellipse; a third star 6" distant revolves in loops, suggesting an invisible companion. Four binaries have been discovered by the spectroscope: β Aurigæ, revolving in a period of four days; α Virginis, four days; ζ Ursæ Majoris, 105 days; and Algol, three days.

The masses of the visual and of spectroscopic binaries are derived by totally different methods, but both classes of bodies indicate that the sun is an undersized star, a result that is confirmed by other and independent lines of investigation. The small range of values presented by the masses of the stars is remarkable, and points to an unexplained uniformity of size in the heavenly bodies, the average component of a double star having a mass somewhat greater than the mass of the earth.

If binary stars are classified with respect to their type of spectrum, it will be found that on the average the distance of a star possessing a Sirian spectrum is about three times as great as that of a star possessing a solar spectrum, and it will further be found that although stars of the Sirian type are, on the whole, more numerous than solar stars, binaries of solar type outnumber their Sirian fellows three to one.

Four-fifths of the binaries, with periods of less than two hundred years, have orbits smaller than Neptune, while the fastest have orbits between Jupiter and Saturn.

A combination of measured amounts of light with elements of orbit is mass-brightness, or "candle-power per ton" (Young). γ Leonis has more than 1000 times the mass-brightness of 61 Cygni—probably. Confining ourselves to those with well-determined orbits, we find at extremes of the list φ Ursæ Majoris, with a mass-brightness fifty-times that of 70 Ophiuchi. The mass-brightness of the sun is probably not much greater than that of 70 Ophiuchi.

It has long been known that if the components of a double

star are of approximately equal brilliancy, they are of the same colour, and if of unequal brilliancy the colour of the fainter companion lies nearer to the violet end of the spectrum than does the colour of the brighter one. The spectra of the stars furnish a partial explanation of their difference in colour by showing, in at least some cases, that the stars possess spectra of different types, the fainter companion having a Sirian, and the brighter one a solar spectrum.

Few researches upon double stars exceed in theoretical interest the mathematical investigations of Mr. See with regard to the mode of development of these bodies. As early as 1878, Doberck had shown, from a statistical comparison of double star orbits, that, in general, the longer the period of revolution of the compounds the larger and more eccentric are their orbits. That the orbits would be larger might be expected as a consequence of the law of gravitation, but it required a special investigation based upon the theory of tidal friction, as developed by Prof. G. H. Darwin, to show that the increasing eccentricities are also a necessary consequence of the same law. The conclusions of Mr. See may be briefly summarised as follows:—If we suppose the components of a double star to be composed of a plastic material, they will produce in each other bodily tides whose effect will be to push the stars asunder, and at the same time to increase the eccentricity of their orbits. This increase of eccentricity will not continue indefinitely, but in the later stages of developments will give way to a diminution of the eccentricities, which will ultimately produce circular orbits. But since the energy of the star is being constantly wasted by radiation, it will, in the later stages of its career, be reduced to invisibility, and during the period of its existence as a luminous body its history will present a continuous increase in the size and eccentricity of its orbit. It is of interest to note in this connection that the two orbits of spectroscopic binaries which have been computed, present eccentricities very much less than that of the average double star orbit, while the dimensions of their orbits are so small as to suggest an early stage in the development of the systems.

Prof. Wm. A. Rogers year by year brings to the Association either new and more refined apparatus, or the result of delicate experiments with the perfected apparatus already at his command. This year he presided over the Section of Physics, and read an elaborate address on obscure heat as an agent in producing the expansion of metals under air contact.

Vice-President Thomas H. Norton addressed the Chemical Section, on the battle with fire; Mansfield Merriman, the Engineering Section, on paradoxes in the resistance of materials; Samuel Calvin, the Geological Section, on some points in geological history illustrated in North-eastern Iowa, exhibiting and using American chalk obtained from the Niobrara beds; Lucien M. Underwood, the Botanical Section, on the evolution of the Hepaticæ, a subject to which he has devoted especial attention, and on which he is probably the foremost authority; Franz Boas, the Anthropological Section, on human faculty as determined by race; and Henry Farquhar, the Economic Section, on a stable monetary standard.

One hundred and seventy-eight papers were read before the Sections, the largest number being before the Section of Anthropology.

It was decided to visit San Francisco next year if suitable rail rates can be secured, and the date of meeting recommended is June or early in July. Definite action, however, was deferred, owing to the expense of crossing the continent, so that time may be taken to apply for special rates of fare.

The following officers for the ensuing year were recommended by the nominating committee, approved by the council, and elected by the Association:—

President, E. W. Morley, Cleveland. Vice-presidents: Mathematics and Astronomy—E. S. Holden, Lick Observatory. Physics—W. Le C. Stevens, Troy, N.Y. Chemistry—William McMurtrie, Brooklyn, N.Y. Mechanical Science and Engineering—William Kent, Passaic, N.J. Geology and Geography—Jed. Hotchkiss, Staunton, Va. Zoology—D. S. Jordan, Palo Alto, Cal. Botany—J. C. Arthur, Lafayette, Ind. Anthropology—F. H. Cushing, Washington, D.C. Economic Science and Statistics—B. E. Fernow, Washington, D.C.; permanent secretary, F. W. Putnam, Cambridge, Mass.; general secretary, James Lewis Howe, Louisville, Ky.; secretary of the council, Charles R. Barnes, Morrison, Wis. Secretaries of the Sections: Mathematics and Astronomy—E. H. Moore, Chicago, Ill.;

Physics—E. Merritt, Ithaca, N.Y.; Chemistry—William P. Mason, Troy, N.Y.; Mechanical Science and Engineering—H. S. Jacoby, Ithaca, N.Y. Geology and Geography—J. Perrin Smith, Palo Alto, Cal. Zoology—S. A. Forbes, Champaign, Ill. Botany—B. T. Galloway, Washington, D.C. Anthropology—Mrs. Anita Newcombe McGee, Washington, D.C. Economic Science and Statistics—E. A. Ross, Palo Alto, Cal. Treasurer, R. S. Woodward, New York.

WM. H. HALE.

THE IRON AND STEEL INSTITUTE.

THE summer meeting of the Iron and Steel Institute has been held this year, for the second time in the history of the Institute, in Belgium, the former meeting in that country having taken place at Liège just twenty-one years ago.

This year's meeting commenced on Monday, August 20, and continued until the following Friday. The President of the Institute, Mr. E. Windsor Richards, presided throughout. The proceedings commenced on the evening of the first day by a reception of members at the beautiful and historic Hôtel de Ville at Brussels, the civic authorities being the hosts. The proceedings were of an exceptionally successful character. On the following morning, Tuesday the 21st ult., the first sitting for the reading of papers was held. The following is a list of the contributions submitted:—

- (1) "On the Use of Caustic Lime in the Blast-Furnace," by Sir Lowthian Bell.
- (2) "On the History of Crucible Steel," by R. A. Hadfield.
- (3) "On the Coal-mining Industry of Belgium," by A. Briart, President of the Society of Engineers, Hainaut.
- (4) "On the Iron and Steel Industries of Belgium," by A. Gillon, President of the Society of Engineers, Liège.
- (5) "On the Influence of Aluminium upon the Carbon in Ferro-Carbon Alloys," by T. W. Hogg, of the Newburn Steel Works.
- (6) "On the Manufacture of Open Hearth Steel," by J. A. Lencauchez, Paris.
- (7) "On Colour Gauges for Carbon Determination," by W. G. McMillan.
- (8) "On Electrical Power in Belgian Iron Works," by D. Selby Bigge.
- (9) "On the Manufacture of Coke," by the late R. de Soldenhoff.
- (10) "On the Iron Ores of the Mediterranean Seaboard," by Arthur P. Wilson.

The papers of Mr. Hadfield and the late M. de Soldenhoff were taken as read.

The members were received in the Bourse des Métaux, where the sittings were held, by M. Gillon and M. Briart, on behalf of the reception committee, and the usual complimentary speeches having been made, business was commenced by the reading of M. Gillon's paper. The title sufficiently indicates the scope of this contribution, and it is evident that an abstract such as, in any case, we could give here would be quite inadequate to so large a subject. The same remark applies to M. Briart's paper, which followed. Both contributions are of considerable interest from an industrial point of view: the first because the Belgians are such keen and successful competitors of our own iron and steel manufacturers in some branches of the industry, and the second from the fact that the coal-mining practice of the Belgians is of a very advanced character. Coal is won in Belgium often under conditions of extreme difficulty, such indeed as would cause despair to mining engineers in our own more favoured land, though doubtless we should rise to the occasion were the necessity put upon us. The natural obstacles which the Belgian engineers are forced to meet have necessitated the highest skill in mining practice, and we cannot but look with admiration at the patience, ingenuity, and skill displayed in the working of many collieries of the country. Sir Lowthian Bell's paper followed. The controversy regarding the respective merits of using caustic lime or raw limestone in the blast furnace is one of much antiquity, and though Sir Lowthian's paper did not perhaps do very much in itself to determine the dispute, it may be said that the paper and the discussion together served to determine the lines upon which the controversy should be carried on. The author said that in the older type of blast furnace it was a desirable thing to calcine the limestone separately, but with the higher furnaces now in vogue there